Advanced Information Systems Technology

Next Generation UAV Based Spectral Systems for Environmental Monitoring

Completed Technology Project (2015 - 2017)

Project Introduction

At present, UAVs used in environmental monitoring mostly collect low spectral resolution imagery, capable of retrieving canopy greenness or properties related water stress. We propose a UAV based capacity for accurate measurement of spectral reflectance at high temporal frequencies and stability to depict diurnal/seasonal cycles in vegetation function. We will test our approaches first using spatially-resolved discrete point measurements characterizing VNIR reflectance and solar-induced fluorescence Y1, followed in Y2 by imaging spectroscopy. The ultimate goal is to produce science-quality spectral data from UAVs suitable for scaling ground measurements and comparison against airborne or satellite sensors. Because of the potential for rapid deployment, spatially explicit data from UAVs can be acquired irrespective of many of the cost, scheduling and logistic limitations to satellite or piloted aircraft missions. Provided that the measurements are suitably calibrated and well characterized, this opens up opportunities for calibration/validation activities not currently available. There is considerable interest in UAVs from the agricultural and forestry industries but there is a need to identify a workflow that yields calibrated comparisons through space and time. This will increase the likelihood that UAVs are economically feasible for applied and basic science, as well as land management. We target the consistent retrieval of calibrated surface reflectance, as well as biological parameters including chlorophyll fluorescence, photosynthetic capacity, nutrient and chlorophyll content, specific leaf area and leaf area index- all important to vegetation monitoring and yield. Scientifically, deployment of UAV sensors at sites such as flux towers will facilitate more frequent (e.g. within-day) and spatially comprehensive assessment of the vegetation physiology and function within tower footprints than is possible by foot, from sensors fixed to the tower, or irregular aircraft missions. We propose a rapid data assimilation and delivery system based on past SensorWeb efforts to move calibrated reflectance data and derived retrievals directly from the UAV to users. We will utilize SensorWeb functionalities to strategically run a data gathering campaign to optimize data yield. As well, we propose a mission deployment system to optimize flight paths based on real-time in-flight data processing to enable effective data collection strategies. All spectral data will also be uploaded to NASA's in-development EcoSIS online spectral library, and we will employ a cloud system to manage the intermediate products. Ultimately, we will demonstrate the acquisition of science-grade spectral measurements from UAVs to advance the use of UAVs in remote sensing beyond current state of application, providing measurements of a quality comparable to those from handheld instruments or well-calibrated air- and spaceborne systems. A key benefit is that UAV collections at 10-150m altitude bridge the gap between ground/proximal measurements and airborne measurements typically acquired at 500m and higher, allowing better linkage of comparable measurements across the full range of scales from the ground to satellites. This proposal is directly responsive to the AIST NRA in that it: bridges the gap in Earth observation between field and airborne

Image Not Available

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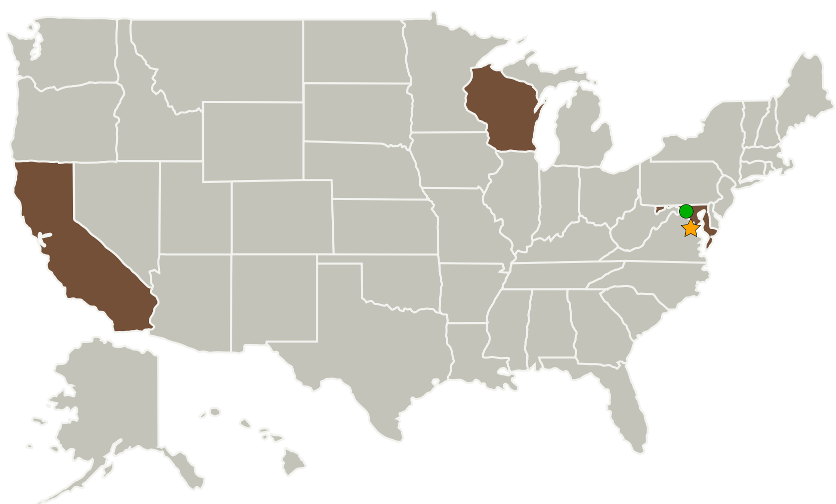
measurements; and reduces risk to NASA through development of methods to make well-characterized measurements from UAVs for integration, calibration and validation of NASA satellite and airborne data, makes use of a data delivery system in which measurements and derived products are rapidly distributed to users, and provides spatially explicit data of calibrated reflectance and vegetation traits new temporal and spatial scales not currently available. We submit in the Core Topic area 'Operations Technologies' and are applicable to the 'Ecological Forecasting' subtopic. We will enter at TRL 3 and exit at TRL 5.

Anticipated Benefits

SMAP

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Center / Facility:

NASA Headquarters (HQ)

Responsible Program:

Advanced Information Systems Technology

Project Management

Program Director:

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Jacqueline J Le Moigne

Principal Investigator:

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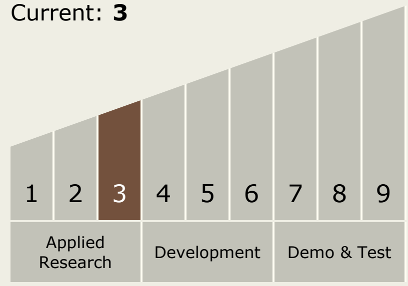
Organizations Performing Work	Role	Type	Location
⭐NASA Headquarters(HQ)	Lead Organization	NASA Center	Washington, District of Columbia
🟢Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
University of Maryland-Baltimore County(UMBC)	Supporting Organization	Academia	Baltimore, Maryland

Primary U.S. Work Locations	
California	Maryland
Wisconsin	

Technology Maturity (TRL)

Start: **3**
Current: **3**



Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  └ TX11.4 Information Processing
    └ TX11.4.2 Intelligent Data Understanding

Target Destination

Earth